

# Steering Committee Meeting #2 Handout

March 9, 2011 @ 2pm

James River and Tributaries – Richmond TMDL Implementation Plan Development

Goochland, Powhatan, Henrico, Chesterfield Counties and City of Richmond, VA

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## BMPs, Reason for inclusion, Bacterial Removal Efficiencies, and Reference

The table below shows the BMPs included in the IPs currently, why they were included, the % efficiency in bacteria removal and a reference for this value.

**Table 1. Potential BMPs, Reason for Inclusion in the IPs, Bacteria Removal Efficiency, and Reference**

Potential BMPs	Why is this in the Draft Plan?	Bacteria Removal Efficiency Used	Reference
<b>STAGE I (1st 10 years)</b>			
<b>Agricultural BMPs:</b>			
Livestock Exclusion with Riparian Buffer (LE-1T, SL-6)	Eliminates Direct Cattle Bacteria & Buffers Filter Bacteria out of Ag Land Runoff	100%	1
Livestock Exclusion with Reduced Set-Back (LE-2T)		100%	1
Stream Protection (WP-2T)		100%	1
Improved Pasture Management	Reduces Ag Land Runoff Bacteria	50%	9
Conservation Tillage – Cropland (SL-15A)	Reduces Erosion and Bacteria on Sediment	61%	2,11
Reforestation of Erodible Cropland (FR-1)	Reduces Erosion and Bacteria on Sediment	Land Use Conversion	
Reforestation of Erodible Pasture (FR-1)	Reduces Erosion and Bacteria on Sediment	Land Use Conversion	
Riparian Buffers – Cropland	Filters Bacteria out of Runoff Water	99%	7
<b>Residential BMPs:</b>			
Septic Systems Pump-outs (RB-1)	Serves as Education to Homeowners; ID Failing Systems	None assigned	
Septic System Repair (RB-3)	Eliminates Human Bacteria Loads	100%	1
Septic System Installation/ Replacement (RB-4)	Eliminates Human Bacteria Loads	100%	1
Alternative Waste Treatment System Installation (RB-5)	Eliminates Human Bacteria Loads	100%	1
<b>Pet Waste Education Program:</b>			
Baggy, Sign and Waste Basket Station	Eliminates Dog Bacteria Loads via Education on Picking-up after Dogs	75%	3
Bag Refills			
Mailings			

## STAGE II (2nd 10 years)

### Agricultural BMPs:

Streamside Fence Maintenance	Keeps Livestock Out of Stream	100%	1
Winter Feeding Facility (WP-4D) – Beef	Reduces Trampling/Erosion and Bacteria on Sediment	85%	10
Waste Storage – Horse	Reduces Bacteria in Runoff by Covering Manure/Die-off	85%	10
Retention Basins – Pasture	Increase Die-off and Settling	70%	6

### Residential BMPs:

Pet Waste Composters	Eliminates Dog Bacteria Loads	99%	1
Mailings	Further Education	Parts of Pet Waste Education Program	
Bag Refills	Pet Waste Station Maintenance		

### Res./Urban SW BMPs:

Retention Ponds	Stores SW / Increase Die-off	70%	6
Rain Gardens	Stores, ETs, Infiltrates SW/ Increase Die-off	70%	5
Bioretention Basins	Stores, ETs, Infiltrates SW/ Increase Die-off	90%	4
Infiltration Trench	ETs, Infiltrates SW/ Increase Die-off	90%	8

### CSO SW Vol. Red. BMPs:

Retro-fitted Green Roofs	Stores SW and ETs Water	Reduces Volume of SW thus Lowering Bacteria Load from Overflows	
Bioretention Basins	Stores SW and ETs Water		
Rain Barrels	Stores SW for Later Use		
Cisterns	Stores SW for Later Use/Slower Release Back to CSO		
Pervious Pavement	Allows for Infiltration of SW		
Increased Storage within the CSO System	Needed for Gillie and Almond CSO reduction beyond LTCP		

Buffer efficiencies shown here apply to runoff generated outside of the buffer area, but within a distance equal to twice the buffer width. Additional reductions result from the conversion of land from its existing condition to the buffer area.

- 1 Removal efficiency is defined by the practice.
- 2 Commonwealth of Virginia. 2005. Chesapeake Bay Nutrient and Sediment Reduction Tributary Strategy for the James River, Lynnhaven, and Poquoson Coastal Basins.  
[http://www.richmondregional.org/Publications/Reports\\_and\\_Documents/Planning/2005\\_james\\_river\\_tributary\\_strategy.pdf](http://www.richmondregional.org/Publications/Reports_and_Documents/Planning/2005_james_river_tributary_strategy.pdf)
- 3 Swann, C. 1999. A survey of residential nutrient behaviors in the Chesapeake Bay. Widener Burrows, Inc. Chesapeake Bay Research Consortium. Center for Watershed Protection. Ellicott City, MD. 112pp.
- 4 US EPA. "Storm Water Technology Fact Sheet Bioretention." (1999): 8.
- 5 Hunt, William F, Jonathan T Smith, and Jon Hathaway. City of Charlotte Pilot BMP Monitoring Program , Mal Marshall Bioretention Final Monitoring Report. City of Charlotte, 2007.
- 6 Center for Watershed Protection. 2007. National Pollutant Removal Performance Database Version 3.  
[http://www.richmondregional.org/Publications/Reports\\_and\\_Documents/Planning/2005\\_james\\_river\\_tributary\\_strategy.pdf](http://www.richmondregional.org/Publications/Reports_and_Documents/Planning/2005_james_river_tributary_strategy.pdf)
- 7 Tate, K. W., Atwill, E. R., Bartolome, J. W. & Nader, G. 2006 Significant Escherichia coli attenuation by vegetative buffers on annual grasslands. J. Environ. Qual. 35, 795–805.
- 8 US EPA. "Storm Water Technology Fact Sheet Infiltration Trench." (1999): 7.
- 9 The Commonwealth of Virginia: Department of Conservation and Recreation and the Department of Environmental Quality. "Guidance Manual for Total Maximum Daily Load Implementation Plans." July 2003.  
<http://www.deq.state.va.us/tmdl/implans/ipguide.pdf>
- 10 Based on measurements of bacteria density as excreted and after storage.
- 11 Bacteria removal efficiency estimated based on sediment and nutrient removal efficiency.

## CSO Stormwater BMP Quantification Explanation:

The stormwater volume reducing BMPs were quantified for only the areas draining to CSOs. There is text in the draft IP document: “It should be noted here that stormwater removal has the potential to increase bacteria concentrations in surface waters by decreasing dilution. These LID practices prevent runoff from areas with few bacteria sources, limiting the dilution effect from this relatively low bacteria-containing water. However, implementing LID practices in the non-CSO areas is recommended in some instances. For example, residential yards may contain high levels of bacteria from pets, and should roof runoff passes through this area quickly to a stream or storm drain, bacteria transport from the yard is highly likely. The varying degree to which these LID practices benefit the non-CSO areas makes their benefit to bacteria load reduction difficult to quantify. These BMPs should be promoted in the non-CSO watersheds, but are not quantified here.”

The table below shows the acreages that have potential to be converted to a green roof or permeable pavement, collect runoff in rain barrels, or collect runoff in bioretention areas. The analyses below show the total gallons of overflow and # of CSO days. These analyses were done for the entire modeling time period 1974-1978.

**Table 2. Potential Stormwater BMP acres in CSO drainage areas.**

<b>Impairment</b>	<b>Drainage Area Within CSO areas only (acres)</b>	<b>Potential Roof Runoff Retention areas Buildings 800 - 3,600 ft2 acres</b>	<b>Potential Green Roof areas 80% of Buildings &gt; 10,000 ft2 acres</b>	<b>Potential Permeable Pavement or Bioretention areas Sidewalks, Parking Lots, etc. acres</b>
<b>Almond Creek</b>	124	20	0.4	9
<b>Bernards Creek</b>	0	0	0	0
<b>Falling Creek</b>	0	0	0	0
<b>Gillie Creek</b>	1,188	141	11.2	107
<b>Goode Creek</b>	0	0	0	0
<b>James River (riverine)</b>	3,720	209	96.8	389
<b>James River (tidal)</b>	9,276	741	478.4	1,594
<b>No Name Creek</b>	0	0	0	0
<b>Powwhite Creek</b>	0	0	0	0
<b>Reedy Creek</b>	0	0	0	0
<b>Tuckahoe Creek</b>	0	0	0	0

### Roof Runoff Retention Systems (rain barrels and cisterns) Modeling Assumptions

- Considered all buildings with 800 – 3,600 ft<sup>2</sup> footprint
- Assumed a 50 gallon capacity for every 250 ft<sup>2</sup> of roof space for rain barrels
- Assumed that detention system drains completely each day
- This analysis is the maximum potential CSO reductions possible from the installation of rain barrels or cisterns
- 1 cistern = 10 rain barrels = 500 gallons (assumed 10% of the need would be cisterns, the rest would be rain barrels)

**Table 3. Potential reduction of CSOs when the maximum possible rain barrels are installed.**

Impairment	CSOs Analyzed	With Alternative E	With Alternative E	With Alternative E and Maximum Rain Barrels	With Alternative E and Maximum Rain Barrels	% Reduction	% Reduction in # CSO days
		Total gal	# CSO days	Total gal	# CSO days	Total gal	days
Almond	12	1.29E+09	268	1.25E+09	214	3.2%	20%
Gillie	4,24,26,25,31,39	8.19E+09	297	8.02E+09	271	2.1%	9%
JR riverine*	7,10,11,15,16,18,19,20,33,40	2.46E+10	369	2.44E+10	305	0.9%	17%
JR tidal*	5,6,14,21,34,35	1.33E+11	295	1.32E+11	145	0.5%	51%

\*These impairments did not require reductions to CSO bacteria loads beyond the LTCP Alternative E. The LID practices are quantified here due to stakeholder requests.

## Green Roofs

- Considered all buildings (private and publicly owned) greater than 10,000 ft<sup>2</sup>
- Assumed 80% of building footprint was available for green roof application
- Assumed the buildings were structurally sound and capable of supporting the green roof materials
- Assumed 3-4 inch deep extensive green roof
- Assumed capability of retaining 1 inch of rainfall
- Used evapotranspiration rates to calculate “recharge” of storage capacity
- This analysis is the maximum potential CSO reductions possible from the installation of green roofs

**Table 4. Potential reduction of CSOs when the maximum possible green roofs are installed.**

Impairment	CSOs Analyzed	With Alternative E	With Alternative E	With Alternative E and Maximum Green Roofs	With Alternative E and Maximum Green Roofs	% Reduction	% Reduction in # CSO
		Total gal	# CSO days	Total gal	# CSO days	Total gal	days
Almond	12	1.29E+09	268	1.29E+09	268	0.04%	0%
Gillie	4,24,26,25,31,39	8.19E+09	297	8.18E+09	292	0.2%	2%
JR riverine*	7,10,11,15,16,18,19,20,33,40	2.46E+10	369	2.45E+10	348	0.5%	6%
JR tidal*	5,6,14,21,34,35	1.33E+11	295	1.32E+11	249	0.2%	16%

\*These impairments did not require reductions to CSO bacteria loads beyond the LTCP Alternative E. The LID practices are quantified here due to stakeholder requests.

## Porous Pavement

- Considered all parking lots
- Assumed 1 inch of rainfall infiltration, available each day
- This analysis is the maximum potential CSO reductions possible from the installation of porous/permeable/pervious pavement

**Table 5. Potential reduction of CSOs when the maximum possible porous pavement is installed.**

Impairment	CSOs Analyzed	With Alternative E		With Alternative E and Maximum Porous Pavement		With Alternative E and Maximum Porous Pavement	
		Total gal	# CSO days	Total gal	# CSO days	% Reduction	% Reduction in # CSO days
Almond	12	1.29E+09	268	1.27E+09	248	1.3%	7%
Gillie	4,24,26,25,31,39	8.19E+09	297	7.98E+09	269	2.6%	9%
JR riverine*	7,10,11,15,16,18,19,20,33,40	2.46E+10	369	2.38E+10	330	3.3%	11%
JR tidal*	5,6,14,21,34,35	1.33E+11	295	1.31E+11	234	1.2%	21%

\*These impairments did not require reductions to CSO bacteria loads beyond the LTCP Alternative E. The LID practices are quantified here due to stakeholder requests.

## Bioretention Basins

- Considered all parking lots
- Assumed basins sized for 0.75 inches of rainfall retention
- Assumed bioretention basin is sized to 10 percent of area-treated
- Assumed bioretention basin is of sufficient design to drain completely each day
  - Assumed soils of adequate percolation, *or* sufficient under-drain design
- This analysis is the maximum potential CSO reductions possible from the installation of bioretention basins

**Table 6. Potential reduction of CSOs when the maximum possible bioretention basin area is installed.**

Impairment	CSOs Analyzed	With Alternative E	With Alternative E	With Alternative E and Maximum Bioretention	With Alternative E and Maximum Bioretention	% Reduction	% Reduction in # CSO days
		Total gal	# CSO days	Total gal	# CSO days	Total gal	days
Almond	12	1.29E+09	268	1.28E+09	251	0.8%	6%
Gillie	4,24,26,25,31,39	8.19E+09	297	8.07E+09	270	1.5%	9%
JR riverine*	7,10,11,15,16,18,19,20,33,40	2.46E+10	369	2.41E+10	333	2.0%	10%
JR tidal*	5,6,14,21,34,35	1.33E+11	295	1.32E+11	236	0.7%	20%

\*These impairments did not require reductions to CSO bacteria loads beyond the LTCP Alternative E. The LID practices are quantified here due to stakeholder requests.

**Table 7. Comparison of CSO Storage Needed to meet the TMDL goals and the Maximum CSO Storage Gained by Implementing LID Practices.**

Impairment	CSOs Analyzed	Maximum Daily Storage				
		COR's Analysis: Storage Needed Beyond Alt E gallons	MapTech's Analysis: Maximum Rain Barrels/ Cisterns gallons	MapTech's Analysis: Maximum Green Roofs gallons	MapTech's Analysis: Maximum Porous Pavement** gallons	MapTech's Analysis: Maximum Bioretention** gallons
Almond	12	2,000,000	178,050	10,083	183,279	91,639
Gillie	4,24,26,25,31,39	29,200,000	1,025,250	304,107	2,178,980	1,089,490
JR riverine*	7,10,11,15,16,18,19,20,33,40	0	2,045,379	2,628,352	7,921,713	3,960,856
JR tidal*	5,6,14,21,34,35	0	6,188,700	12,989,708	32,460,694	16,230,347

\*These impairments did not require reductions to CSO bacteria loads beyond the LTCP Alternative E. The LID practices are quantified here due to stakeholder requests.

\*\*Since porous pavement and bioretention basins target runoff from the same area (parking lots etc), only porous pavement was used in the draft IP scenarios below as to not double count stormwater volume storage.



**Table 8. Draft Implementation Plan for Bernards Creek watershed.**

<b>Bernards Creek BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	10	\$250,000
LE with Reduced Set-Back (LE-2T)	System	\$25,000	1	\$25,000
Stream Protection (WP-2T)	System	\$8,000	1	\$8,000
Improved Pasture Management	Acre	part of LE system	400	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	45	\$4,500
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	42	\$6,468
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	79	\$12,166
Riparian Buffers – Cropland	Acre	\$360	5	\$1,800
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	300	\$135,000
Septic System Repair (RB-3)	System	\$3,500	6	\$21,000
Septic System Installation/Replacement (RB-4)	System	\$8,000	18	\$144,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	1	\$20,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	0	\$0
Mailings	Each	\$0.36	2,266	\$816
<i>StageI Subtotal</i>				<i>\$628,750</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	1,034	\$3,619
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	16	\$48,000
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	2,266	\$816
Bag Refills	Each	\$0.10	0	\$0
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	68	\$231,200
Rain Gardens	Acre-Treated	\$5,000	68	\$340,000
Bioretention Basins	Acre-Treated	\$10,000	68	\$680,000
Infiltration Trench	Acre-Treated	\$5,285	67	\$354,095
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$1,657,730</i>
<b>Bernards Creek Grand Total</b>				<b>\$2,286,480</b>

**Table 9. Draft Implementation Plan for Tuckahoe Creek watershed.**

<b>Tuckahoe Creek BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	50	\$1,250,000
LE with Reduced Set-Back (LE-2T)	System	\$25,000	5	\$125,000
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	41	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	119	\$11,900
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	152	\$23,408
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	8	\$1,232
Riparian Buffers – Cropland	Acre	\$360	112	\$40,320
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	681	\$306,450
Septic System Repair (RB-3)	System	\$3,500	46	\$161,000
Septic System Installation/Replacement (RB-4)	System	\$8,000	166	\$1,328,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	58	\$1,160,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	10	\$1,700
Bag Refills	Each	\$0.10	365,000	\$36,500
Mailings	Each	\$0.36	36,455	\$13,124
<i>StageI Subtotal</i>				<i>\$4,458,634</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	4,770	\$16,695
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	14	\$140,000
Waste Storage – Horse	System	\$3,000	56	\$168,000
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	1,813	\$90,664
Mailings	Each	\$0.36	36,455	\$13,124
Bag Refills	Each	\$0.10	365,000	\$36,500
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	0	\$0
Rain Gardens	Acre-Treated	\$5,000	6,443	\$32,215,000
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Infiltration Trench	Acre-Treated	\$5,285	6,443	\$34,051,255
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$66,731,237</i>
<b>Tuckahoe Creek Grand Total</b>				<b>\$71,189,871</b>

**Table 10. Draft Implementation Plan for Powwhite Creek watershed.**

<b>Powwhite Creek BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	1	\$25,000
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system		
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	0	\$0
Septic System Installation/Replacement (RB-4)	System	\$8,000	4	\$32,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	0	\$0
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	2	\$340
Bag Refills	Each	\$0.10	73,000	\$7,300
Mailings	Each	\$0.36	11,053	\$3,979
<i>StageI Subtotal</i>				<i>\$68,619</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	40	\$140
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	11,053	\$3,979
Bag Refills	Each	\$0.10	73,000	\$7,300
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	78	\$265,200
Rain Gardens	Acre-Treated	\$5,000	78	\$390,000
Bioretention Basins	Acre-Treated	\$10,000	78	\$780,000
Infiltration Trench	Acre-Treated	\$5,285	78	\$412,230
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$1,858,849</i>
<b>Powwhite Creek Grand Total</b>				<b>\$1,927,468</b>

**Table 11. Draft Implementation Plan for Reedy Creek watershed.**

Reedy Creek BMP Needs	Unit	Cost per unit	# Units	Total Cost
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	1	\$3,500
Septic System Installation/Replacement (RB-4)	System	\$8,000	8	\$64,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	0	\$0
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	6	\$1,020
Bag Refills	Each	\$0.10	219,000	\$21,900
Mailings	Each	\$0.36	9,311	\$3,352
<i>StageI Subtotal</i>				<i>\$93,772</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	658	\$32,900
Mailings	Each	\$0.36	9,311	\$3,352
Bag Refills	Each	\$0.10	219,000	\$21,900
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	615	\$2,091,000
Rain Gardens	Acre-Treated	\$5,000	615	\$3,075,000
Bioretention Basins	Acre-Treated	\$10,000	617	\$6,170,000
Infiltration Trench	Acre-Treated	\$5,285	615	\$3,250,275
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$14,644,427</i>
<b>Reedy Creek Grand Total</b>				<b>\$14,738,199</b>

**Table 12. Draft Implementation Plan for James River (riverine) watershed.**

<b>James River (riverine) BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	73	\$1,825,000
LE with Reduced Set-Back (LE-2T)	System	\$25,000	8	\$200,000
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	2,342	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	88	\$8,800
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	112	\$17,248
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	462	\$71,148
Riparian Buffers – Cropland	Acre	\$360	83	\$29,880
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	1,790	\$805,500
Septic System Repair (RB-3)	System	\$3,500	113	\$395,500
Septic System Installation/Replacement (RB-4)	System	\$8,000	316	\$2,528,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	20	\$400,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	1,022,00	\$102,200
Mailings	Each	\$0.36	26,353	\$9,487
<i>StageI Subtotal</i>				\$6,392,763
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	7,000	\$24,500
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	28	\$280,000
Waste Storage – Horse	System	\$3,000	104	\$312,000
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	1,311	\$65,540
Mailings	Each	\$0.36	26,353	\$9,487
Bag Refills	Each	\$0.10	1,022,00	\$102,200
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	0	\$0
Rain Gardens	Acre-Treated	\$5,000	5,377	\$26,885,000
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Infiltration Trench	Acre-Treated	\$5,285	5,377	\$28,417,445
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				\$56,096,172
<b>James River (riverine) Grand Total</b>				<b>\$62,488,935</b>

**Table 13. Draft Implementation Plan for Gillie Creek watershed.**

Gillie Creek BMP Needs	Unit	Cost per unit	# Units	Total Cost
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	1	\$3,500
Septic System Installation/Replacement (RB-4)	System	\$8,000	24	\$192,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	36	\$720,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	18	\$3,060
Bag Refills	Each	\$0.10	657,000	\$65,700
Mailings	Each	\$0.36	17,768	\$6,396
<i>StageI Subtotal</i>				<i>\$990,656</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	17,768	\$6,396
Bag Refills	Each	\$0.10	657,000	\$65,700
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	739	\$2,512,600
Rain Gardens	Acre-Treated	\$5,000	740	\$3,700,000
Bioretention Basins	Acre-Treated	\$10,000	740	\$7,400,000
Infiltration Trench	Acre-Treated	\$5,285	740	\$3,910,900
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	609,840	\$18,295,200
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	18,455	\$2,768,175
Cisterns	Each	\$1,000	205	\$205,000
Pervious Pavement	Sq. Ft.	\$24	4,660,920	\$111,862,080
Increased Storage within the CSO System*	Gallons		25,700,000	\$257,000,000
<i>StageII Subtotal</i>				<i>\$407,726,051</i>
<b>Gillie Creek Grand Total</b>				<b>\$408,716,708</b>

\*based on COR estimate of total need to meet the TMDL (29.2MG) and cost (\$300M), minus storage gained by estimated maximum amount of LID practices (3.5MG; see Table7); cost was extrapolated from Table sent with TMDL comments

**Table 14. Draft Implementation Plan for Almond Creek watershed.**

<b>Almond Creek BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	1	\$25,000
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system		
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	0	\$0
Septic System Installation/Replacement (RB-4)	System	\$8,000	3	\$24,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	5	\$100,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	0	\$0
Mailings	Each	\$0.36	3,380	\$1,217
<i>StageI Subtotal</i>				<i>\$150,217</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	6	\$21
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50		\$0
Mailings	Each	\$0.36	3,380	\$1,217
Bag Refills	Each	\$0.10	0	\$0
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	0	\$0
Rain Gardens	Acre-Treated	\$5,000	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Infiltration Trench	Acre-Treated	\$5,285	0	\$0
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	20,221	\$606,617
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	3,205	\$480,735
Cisterns	Each	\$1,000	36	\$36,000
Pervious Pavement	Sq. Ft.	\$24	392,040	\$9,408,960
Increased Storage within the CSO System*	Gallons		1,600,000	\$12,160,000
<i>StageII Subtotal</i>				<i>\$22,693,549</i>
<b>Almond Creek Grand Total</b>				<b>\$22,843,766</b>

\*based on COR estimate of total need to meet the TMDL (2MG) and cost (\$12.6M), minus storage gained by estimated maximum amount of LID practices (0.4MG; see Table7); cost was extrapolated from Table sent with TMDL comments

**Table 15. Draft Implementation Plan for Goode Creek watershed.**

Goode Creek BMP Needs	Unit	Cost per unit	# Units	Total Cost
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	1	\$3,500
Septic System Installation/Replacement (RB-4)	System	\$8,000	5	\$40,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	0	\$0
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	0	\$0
Mailings	Each	\$0.36	7,758	\$2,793
<i>StageI Subtotal</i>				<i>\$46,293</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	7,758	\$2,793
Bag Refills	Each	\$0.10	0	\$0
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	433	\$1,472,200
Rain Gardens	Acre-Treated	\$5,000	434	\$2,170,000
Bioretention Basins	Acre-Treated	\$10,000	434	\$4,340,000
Infiltration Trench	Acre-Treated	\$5,285	434	\$2,293,690
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	
<i>StageII Subtotal</i>				<i>\$10,278,683</i>
<b>Goode Creek Grand Total</b>				<b>\$10,324,976</b>



**Table 16. Draft Implementation Plan for Falling Creek watershed.**

<b>Falling Creek BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	0	\$0
Septic System Installation/Replacement (RB-4)	System	\$8,000	7	\$56,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	0	\$0
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	20	\$3,400
Bag Refills	Each	\$0.10	730,000	\$73,000
Mailings	Each	\$0.36	45,811	\$16,492
<i>StageI Subtotal</i>				<i>\$148,892</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	45,811	\$16,492
Bag Refills	Each	\$0.10	730,000	\$73,000
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	0	\$0
Rain Gardens	Acre-Treated	\$5,000	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Infiltration Trench	Acre-Treated	\$5,285	0	\$0
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$89,492</i>
<b>Falling Creek Grand Total</b>				<b>\$238,384</b>

**Table 17. Draft Implementation Plan for No Name Creek watershed.**

No Name Creek BMP Needs	Unit	Cost per unit	# Units	Total Cost
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	0	\$0
Septic System Installation/Replacement (RB-4)	System	\$8,000	1	\$8,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	0	\$0
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	0	\$0
Mailings	Each	\$0.36	869	\$313
<i>StageI Subtotal</i>				<i>\$8,313</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50		\$0
Mailings	Each	\$0.36	869	\$313
Bag Refills	Each	\$0.10	0	\$0
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	61	\$207,400
Rain Gardens	Acre-Treated	\$5,000	62	\$310,000
Bioretention Basins	Acre-Treated	\$10,000	62	\$620,000
Infiltration Trench	Acre-Treated	\$5,285	62	\$327,670
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$1,465,383</i>
<b>No Name Creek Grand Total</b>				<b>\$1,473,696</b>

**Table 18. Draft Implementation Plan for James River (tidal) watershed.**

<b>James River (tidal) BMP Needs</b>	<b>Unit</b>	<b>Cost per unit</b>	<b># Units</b>	<b>Total Cost</b>
<b>STAGE I (1st 10 years)</b>				
<b>Agricultural BMPs:</b>				
Livestock Exclusion Systems:				
Livestock Exclusion with Riparian Buffer (LE-1T)	System	\$25,000	0	\$0
LE with Reduced Set-Back (LE-2T)	System	\$25,000	0	\$0
Stream Protection (WP-2T)	System	\$8,000	0	\$0
Improved Pasture Management	Acre	part of LE system	0	
Conservation Tillage – Cropland (SL-15A)	Acre	\$100	0	\$0
Reforestation of Erodible Cropland (FR-1)	Acre	\$154	0	\$0
Reforestation of Erodible Pasture (FR-1)	Acre	\$154	0	\$0
Riparian Buffers – Cropland	Acre	\$360	0	\$0
<b>Residential BMPs:</b>				
Septic Systems Pump-outs (RB-1)	System	\$450	0	\$0
Septic System Repair (RB-3)	System	\$3,500	2	\$7,000
Septic System Installation/Replacement (RB-4)	System	\$8,000	66	\$528,000
Alt. Waste Treatment System Installation (RB-5)	System	\$20,000	60	\$1,200,000
<b>Pet Waste Education Program:</b>				
Baggy, Sign and Waste Basket Station	Station	\$170	0	\$0
Bag Refills	Each	\$0.10	0	\$0
Mailings	Each	\$0.36	0	\$0
<i>StageI Subtotal</i>				<i>\$1,735,000</i>
<b>STAGE II (2nd 10 years)</b>				
<b>Agricultural BMPs:</b>				
Streamside Fence Maintenance	Feet	\$3.50	0	\$0
Winter Feeding Facility (WP-4D) – Beef	System	\$10,000	0	\$0
Waste Storage – Horse	System	\$3,000	0	\$0
Retention Basins – Pasture	Acre-Treated	\$140	0	\$0
<b>Pet Waste BMPs:</b>				
Pet Waste Composters	Composter	\$50	0	\$0
Mailings	Each	\$0.36	0	\$0
Bag Refills	Each	\$0.10	0	\$0
<b>Residential/Urban Stormwater BMPs:</b>				
Retention Ponds	Acre-Treated	\$3,400	0	\$0
Rain Gardens	Acre-Treated	\$5,000	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Infiltration Trench	Acre-Treated	\$5,285	0	\$0
<b>CSO SW Volume Reduction BMPs:</b>				
Retro-fitted Green Roofs	Sq. Ft.	\$30	0	\$0
Bioretention Basins	Acre-Treated	\$10,000	0	\$0
Rain Barrels	Each (50gal)	\$150	0	\$0
Cisterns	Each	\$1,000	0	\$0
Pervious Pavement	Sq. Ft.	\$24	0	\$0
Increased Storage within the CSO System	Gallons		0	\$0
<i>StageII Subtotal</i>				<i>\$0</i>
<b>James River (tidal) Grand Total</b>				<b>\$1,735,000</b>

The JR riverine and JR tidal impairments did not require reductions to CSO bacteria loads beyond what is currently planned in the COR's LTCP Alternative E. However, folks may be interested in the same maximum LID analysis which is shown in Table 19.

**Table 19. Possible maximum LID BMPs for the riverine and tidal James River areas.**

Potential BMPs	Unit	# Units Installed/ Planned	Cost per unit	# Units*	Total Cost
<b>Reedy Creek CSO SW Volume Reduction</b>					
<b>BMPs:</b>					
Retro-fitted Green Roofs	Sq. Ft.	0	\$30	348,480	\$10,454,400
Bioretention Basins	Acre-Treated	0	\$10,000	0	\$0
Rain Barrels	Each (50gal)	0	\$150	11,165	\$1,674,810
Cisterns	Each (500gal)	0	\$1,000	124	\$124,000
Pervious Pavement	Sq. Ft.	0	\$24	3,136,320	\$75,271,680
Increased Storage within the CSO System	Gallons			0	\$0
<i>Reedy Creek Total</i>					<i>\$87,524,890</i>
<b>JR (riverine) CSO SW Volume Reduction</b>					
<b>BMPs:</b>					
Retro-fitted Green Roofs	Sq. Ft.	0	\$30	4,922,280	\$147,668,400
Bioretention Basins	Acre-Treated	0	\$10,000	0	\$0
Rain Barrels	Each (50gal)	0	\$150	32,557	\$4,883,550
Cisterns	Each (500gal)	0	\$1,000	362	\$362,000
Pervious Pavement	Sq. Ft.	0	\$24	13,808,520	\$331,404,480
Increased Storage within the CSO System	Gallons			0	\$0
<i>JR riverine Total</i>					<i>\$484,318,430</i>
<b>JR (tidal) CSO SW Volume Reduction</b>					
<b>BMPs:</b>					
Retro-fitted Green Roofs	Sq. Ft.	26,981	\$30	31,902,499	\$957,074,970
Bioretention Basins	Acre-Treated	0	\$10,000	1,594	\$15,940,000
Rain Barrels	Each (50gal)	0	\$150	111,397	\$16,709,550
Cisterns	Each (500gal)	0	\$1,000	1,238	\$1,238,000
Pervious Pavement	Sq. Ft.	131,146	\$24	91,301,294	\$2,191,231,056
Increased Storage within the CSO System	Gallons			0	\$0
<i>JR tidal Total</i>					<i>\$3,182,193,576</i>

\*Existing and currently planned Green Urban BMP drainage areas were subtracted from the original total estimations to get these #Units.